ANALYSIS OF LANDBIRD MONITORING DATA FOR NATIONAL PARKS IN THE GREAT LAKES NETWORK

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Abstract

Breeding landbird monitoring programs have been initiated on several of the National Park units in the Great Lakes Network. Methodologies and study design vary among the park units. Our objectives were to describe landbird monitoring programs in the Great Lakes Network, conduct a power analysis of existing data, address the adequacy of each park's program and provide methodological suggestions to facilitate regional population assessments, and provide a written protocol, standard data sheets, Microsoft Access database for data entry, and metadata for the database. For the power analysis, we used the program TRENDS to evaluate the number of years of monitoring required to detect a significant population trend for ten species in three abundance classes (high, moderate, and low). Species in the high abundance class required 8.9 years of monitoring to detect a 10% trend, while the medium and low abundance classes required 12.7 and 14.2 years, respectively. All monitoring programs have been in place for over five years, with four parks having >8 years of data on a consistent set of points. All six parks have sufficient power to detect a 10% annual change in abundance after 10 years, or a 5% change after 15 years for at least some species. Network-wide recommendations included using a standard protocol, data sheet, and database, clearly stating monitoring objectives, reporting results on an annual basis, describing site selection criteria, and other methodological suggestions. Specific recommendations were also made for each individual park.

Introduction

Seven of the nine National Park units in the Great Lakes Network have initiated breeding landbird monitoring programs. Specific objectives differ among the parks, but often include documenting species occurrence (e.g., checklists), evaluation of habitat use, estimation of population trends, and comparison of population trends with other monitoring programs. Different methodological approaches are required for meeting these objectives. For example, for a checklist of bird species within a park, sightings could be compiled relatively easily from available sources (park personnel, data from previous studies, local birders, visitors logs, etc), with supplemental data from surveys during different seasons or times of day (e.g., searching stopover areas during migration, evening surveys for crepuscular species). An evaluation of habitat use by birds would require quantification of habitats within the park and systematic bird surveys of the habitats of interest.

Estimating population trends or trajectories for individual bird species will require planning and should include standard protocols to ensure that data will meet the intended objective. Data gathered with a standard protocol will be much more valuable in assessing bird population trends (Hanowski and Niemi 1995, Hanowski et al. in press, Howe et al. 1997), and data that are stored in standardized databases will be easier to use in regional comparisons with other monitoring programs. Study designs that incorporate representative sampling of the habitats present are necessary when applying results from monitoring points to a wider area of interest (e.g., a park unit). Given the potential significance of the parks to regional bird populations, it is important to have consistent, effective, and scientifically rigorous monitoring programs in place.

Our objectives are to: 1) describe current landbird monitoring programs and objectives on six parks in the Great Lakes Network (Apostle Islands National Lakeshore, Grand Portage National Monument, Indiana Dunes National Lakeshore, Isle Royale National Park, St. Croix National Scenic Riverway, and Voyageurs National Park), 2) conduct a power analysis of existing data to evaluate the number of years of monitoring required to detect significant population trends given each park's study design, 3) provide a narrative addressing the adequacy of each park's program in meeting their monitoring objectives, and provide suggestions on how data collection methods could be modified to be most useful in regional population assessments, and 4) provide a written protocol to standardize monitoring, standard data sheets for collecting monitoring data, a data form that can be used to enter and store data in an Access database, and metadata for the database.

Methods and Individual Park Overviews

<u>Existing park monitoring programs</u>

Apostle Islands National Lakeshore
The Apostle Islands National Lakeshore (APIS) includes an archipelago of 21 islands and approximately 19 km (12 mi) of Lake Superior shoreline near Bayfield in northwestern Wisconsin. Islands range from 1 to 4,000 ha (3 to 10,000 ac) and include eastern hemlock/white pine/northern hardwood forests, aspen/birch forests, boreal forests, and beach dunes. Approximately eighty percent of the park has been designated wilderness.

A breeding bird monitoring program was initiated in 1990 with the following objectives (Van Stappen and Dallman 1996):

1) conduct long-term monitoring of breeding birds in the Lakeshore through annual surveys to determine trends in avian populations
2) describe important breeding bird habitats within the Lakeshore
3) data collected will be available for comparative use by other established breeding bird surveys.

Survey design and methodology follows recognized protocol (Ralph et al. 1993, Hanowski and Niemi 1995). Ten transects of 5-15 points (106 total points) are sampled annually during June on Devils, Long, Oak, Outer, Raspberry, Sand, and Stockton Islands and the mainland unit (Table 1). Transects were established along trails, except on Raspberry Island, the Outer Island hemlock stand, and the mainland unit. Survey points are separated by approximately 400 m (0.25 mi) and were stratified among habitats according to the overall proportions that are present on the park. In 1995, survey points were permanently marked and some points were moved to ensure equal representation of habitat types (Van Stappen and Dallman 1996). Data from 1995 forward serves as the park's primary long-term bird monitoring data set.

Table 1. Transects sampled on the Apostle Islands National Lakeshore breeding bird monitoring program.

Transect	# of points	Years surveyed
Devils Island	8	1991-1997, 1999-2003
Long Island	12	1990-2003
Mainland	10	1991-2003
Oak Island	13	1991-1997, 1999-2003
Outer Island - N-S Trail	15	1990-2003
Outer Island - Hemlock Stand	5	1991-2003
Raspberry Island	9	1991-1997, 1999-2003
Sand Island	12	1990-2003
Stockton Island - Presque Isle	10	1990-2003
Stockton Island - Trout Point	12	1990-2003

From 1991-1993, point counts were 5 minutes long with 3 and 5-minute intervals. In 1990, point counts were 3 minutes in length. Currently, 10-minute, 100m-radius point counts are conducted once a year at each survey point, with individual birds separated into 5 and 10 minute intervals. Point counts are conducted from ½ hour before sunrise to 0900 Central Daylight Time (CDT), on days with little wind (< 18.5 km/hr) and little or no precipitation. Three transects could not be sampled in 1998 due to weather (Table 1). About 20 different observers have conducted surveys since monitoring was initiated.

Grand Portage National Monument

The Grand Portage National Monument (GRPO) is located in extreme northeastern Minnesota and encompasses 287 ha (710 ac), including a 13.7 km (8.5 mi) historic canoe portage trail buffered by approximately 100 m on each side. Forest types along the trail are mainly mixed conifer-hardwood forests of birch-aspen-spruce-fir.

The breeding bird survey at GRPO was initiated in 1999 with a general objective of assessing species distributions across different forest types on the park (S. Gucciardo, pers. comm.). The survey consists of 38 points along the entire length of the portage trail, from the historic trading post along Lake Superior to the Pigeon River on the US/Canada border. Survey points were selected by distance (400 m apart) commencing on the shore of Lake Superior. The majority of points (34) are in birch-aspen-spruce-fir forest, with three points in streamside shrub habitats, and one at the edge of a mature spruce plantation and an unmowed grass meadow. Given the wide coverage of the survey points in relation to the small size of the park, habitats are probably proportionately sampled.

Ten-minute, unlimited radius point counts are conducted once a year at each survey point. Beginning in 2004, individual birds were recorded as inside or outside of a 100 m radius. Surveys are typically conducted by a skilled observer over three days between June 10 and June 24. Point counts are conducted between 0500 and 0900 CDT, on days with little wind (< 11-12 km/hr) and little or no precipitation.

Indiana Dunes National Lakeshore
Indiana Dunes National Lakeshore (INDU) includes 6,070 ha (15,000 ac) along 40 km (25 mi) of southern Lake Michigan near Michigan City, Indiana. The park contains a diverse assemblage of habitat types including beach dunes, prairies, bogs, oak savannas, northern conifer forests, temperate hardwood forests, and marshes. Agricultural, residential, and industrial areas surround the park.

A U.S. Geological Survey (USGS) Breeding Bird Survey route was established within the park in 1993 and has been sampled every year since. The route is 39.4 km (24.5 mi) long and consists of 50 roadside stops separated by 800 m (0.5 mi). All birds seen or heard within a 400 m radius are recorded within a three-minute interval. The survey is conducted between 0.5 hr before sunrise and 4.5 hours after sunrise on a June morning with good conditions (little or no precipitation and winds < 19 km/hr). The objective of the INDU Breeding Bird Survey is to track population trends of breeding birds.

Isle Royale National Park
Isle Royale National Park (ISRO) is a Lake Superior archipelago of one large island (72 km long and 14 km wide), surrounded by more than 400 small islands. The park is a Biosphere Reserve, and 99% of the land area is designated as Wilderness. Northern boreal forests dominate nearshore areas and northern hardwoods cover much of the island's interior.

The breeding bird survey at ISRO began in 1994 in response to perceived declines in Neotropical migrants (Beeman and Oelfke 1996). Specific objectives have evolved since the beginning of the survey, but since 1997, objectives have been to:

1) determine the size and composition of the neotropical migrant, continental migrant, and resident communities of passerines and other species that are detectable by point counts
2) annually monitor these communities and make general comparisons among years
3) compare the status of these communities with other regional populations.

Seven transects of 16-21 points were established along trails on the main island, with an eighth transect of 4 points on Passage Island (130 total points; Table 2). Survey points are 400 m (0.25 mi) apart, and were permanently marked in 1996. Data from 1994 and 1995 have not been used in analyses for ISRO reports. Survey points were apparently not selected according to habitat, or to be representative of overall habitat composition within the park, although each "region" of the park (east, west, and central) is represented (Egan 2004).

Five-minute, unlimited radius point counts are conducted once a year between June 10 - 30. Point counts are conducted from ½ hour before sunrise to 0900 CDT by one skilled observer and usually one recorder. Recorders go through a brief training session to ensure consistency in recording techniques. Point counts are not conducted during rain, heavy fog, or when winds exceed 16 km/hr (10 mph).

Table 2. Transects sampled on the Isle Royale National Park breeding bird survey.

Transect	# of points
Passage Island	4
Three Mile-Lane Cove	16
Chippewa Harbor-Lake Richie	16
Mt. Ojibway Loop	19
Lake Richie-Greenstone	20
Ishpeming Trail	18
Feldtmann Lake Trail	16
Windigo-Sugar Mt.	21

St. Croix National Scenic Riverway

The St. Croix National Scenic Riverway (SACN) spans 405 km (252 mi) of the St. Croix and Namekagon rivers in eastern Minnesota and northwestern Wisconsin. The Riverway passes through boreal, eastern deciduous, and oak/pine savanna biomes, with wetlands present throughout. There are two primary management units on the park: the upper St. Croix and Namekagon Rivers and the lower St. Croix River.

In 1982 and 1983, river-based breeding bird survey routes were established along the lower St. Croix River and the lower Namekagon River. Three additional routes were added in 2000 and 2003 (Table 3). The general objectives of the SACN bird monitoring program are to:

1) monitor changes in relative abundance of bird populations
2) record evidence of breeding activity in the area
3) provide a data source for a checklist of birds.

Route design is based on the USGS Breeding Bird Survey (Sauer et al. 2004), except that a canoe or motorized boat is used and the 39.4 km (24.5 mi) river routes take two mornings to complete, rather than one. Also, stops are determined by marks on maps at half-mile intervals, and watercraft are allowed to drift during the 3-minute count period, resulting in a “moving” survey point (Maercklein 1999).

Table 3. Transects sampled on the St. Croix National Scenic Riverway breeding bird monitoring program.

Transect	# of points	Years surveyed
Lower Namekagon River	50	1983, 1998, 1999, 2001, 2003
Lower St. Croix River	50-53	1982, 1998, 1999, 2001, 2003
St. Croix River - North	58	2000 (28pts), 2002
Upper Namekagon River	50	2000, 2002
Upper St. Croix River	46	2003

Three-minute, unlimited radius point counts are conducted once every other year at each survey point along the center line of the river. Routes are surveyed in alternate years; two routes are sampled in one year and three routes the next year. Each survey route is conducted by a skilled observer over two mornings in June (the same observer has conducted all but one of the surveys since 1998). Point counts are conducted between 0500 and 0900 CDT, on days with little wind (< 19 km/hr) and little or no precipitation.

Voyageurs National Park

Voyageurs National Park (VOYA) is located on 88,241 ha (218,054 ac) of forest and lakes in northern Minnesota along the Ontario border. The Namakan Basin and Rainy Lake, along with 26 smaller lakes and numerous beaver ponds, cover more than 38% of the park, and access to most of the park is by watercraft. Forests are a mix of boreal spruce/fir and deciduous uplands and lowlands.

A breeding bird inventory and monitoring program was initiated in 1995 by VOYA biologists with the following objectives (Grim et al. 1995):

1) develop protocols for surveying forest breeding birds present in representative forest habitats
2) estimate avian population trends
3) define habitat associations of avian trends
4) discover invasions of exotic species
5) document any recovery periods following significant declines.

Survey design and methodology follows recognized protocol (Ralph et al. 1993, Hanowski and Niemi 1995). Nine transects (10 points each) have been surveyed since 1997 (Table 4). As of 2003, eight transects (80 points total) were actively surveyed, including the Ash River Trail transect added in 2003. As part of an initial pilot study in 1995, a Geographic Information System was used to proportionally stratify points along the Cruiser Lake Trail transect into the seven main forest cover types present on the Kabetogama Peninsula. Points along the remaining transects were also established to be representative of habitats present on the park (J. Fox, pers. comm.), presumably in the same manner.

Table 4. Transects sampled on the Voyageurs National Park breeding bird inventory and monitoring program.

Transect	# of points	Years surveyed
Anderson Bay	10	2001-2003
Ash River Trail	10	2003
Blind Ash Bay Trail	10	1997-2003
Black Bay Trail	10	1997-2003
Cruiser Lake Trail	10	1995, 1996, 1998
Dryweed Island	10	1998-2003
Echo Bay Trail	10	1997-2003
Lost Bay	10	1999-2001, 2003
Rainy Lake Visitor Center	10	1997-2003

Ten-minute, 100m-radius point counts with 3, 5, and 10 minute intervals are conducted once a year between June 1 and July 7. Observers trained and experienced in point count methodology conduct all surveys. Point counts are conducted between sunrise and 0930 CDT, on mornings with winds < 24 km/h and little or no precipitation.

Power analysis

Because it is impractical to completely census bird populations annually for study regions at the spatial scale of national parks, monitoring programs employ sampling designs aimed at accurately estimating an index of population size annually. Changes in the index through time are thought to reflect changes in population size through time. The main challenge faced in detecting population trends is that sources of variation in the index, that are in addition to natural year-to-year population fluctuations, can obscure the true population trend. Such sources include variation in the environment that influences species detections (e.g., wind and rain) and variation attributable to counting methodology (e.g., observer differences, number of points, duration of point counts, and duration of the monitoring program). If sources of variation are not considered during sampling design and analysis, a study runs the risk of failing to conclude a population has a significant trend when in fact a trend is occurring. This may be especially damaging in the case of declining species.

We define trend as the slope of a simple linear regression of the natural log (ln)-transformed annual index of population size vs. time (year) (Gerrodette 1987). We note the distinction between population *trajectory* and population *trend* (Link and Sauer 1997). While trajectory is the path of population change through time, including ups and downs and potential non-linearities, population trend is a statement of the direction and magnitude of population change for a specified time interval. Thus, trend can be evaluated with linear methods without asserting the trajectory to be linear (Urquhart and Kincaid 1999).

Statistical power is the probability of detecting a significant regression slope when a trend in population size is in fact occurring, despite variation in the annual index. Power is positively related to the number of sampling occasions, the number of sample points, the magnitude of the trend, and the alpha-level of the statistical test; power is negatively related to sampling variance (Gerrodette 1987). Having too few years of monitoring could render the results of the monitoring program useless – power may be too low to make any conclusions with confidence. Population variance estimates from prior years' monitoring can be used in a power analysis to inform scientists and managers about the efficacy of a monitoring program.

For 10 species from each park we evaluated the number of years of monitoring required to detect a significant population trend using the program TRENDS (Gerrodette 1993). This program is available at no cost via the internet at (http://swfsc.nmfs.noaa.gov/PRD/software/Trends.html). The number of years required is a function of several parameters that can be modified by the user. We specified: 1) $\alpha = 0.05$, 2) power = 0.8, 3) Coefficient of Variation (CV) proportional to $1/A^{0.5}$, 4) exponential population change, and 5) trend to be detected = 2%, 5%, and 10% per year. Additionally, the user must enter a measure of variation (CV) about the trend line. We used the root mean square error from a simple linear regression of ln-transformed mean count per park survey vs. year as the measure of variation (Gerrodette 1987; Nur et al. 1999). Data for the regressions came from prior monitoring data from each park.

We made several restrictions on the available data to make the power analysis consistent across parks. One 100-m radius survey was used per point for each year for all parks except ISRO and SACN, for which an unlimited radius was used. Count duration was 10 minutes for APIS, GRPO, and VOYA, 5 minutes for ISRO, and 3 minutes for INDU and SACN. We computed an annual index of abundance for each species by calculating the mean number of detected individuals per survey. Because some points may be missed or excluded in some years, we used the mean count per survey as the index of population size rather than the sum of abundances across all points. For relatively large samples, missing a small fraction of points in one year will have a small effect. Excluding some points can have a substantial effect if the number of excluded points is large or restricted to particular habitats. Trends were identified by simple linear regression of ln(mean abundance per survey) vs. time. We considered data from individual point counts too small to compute trends (Thompson et al. 2002), thus we did not use a route-regression approach. We used the natural logarithm of the annual index rather than the raw index itself because we considered population change for breeding songbirds to generally be a multiplicative process, i.e., with an increase of each unit of time, population size increases by a constant proportion.

Bird species were grouped in three abundance classes (high, moderate, and low) to evaluate the relationship between abundance and required monitoring duration (in years). The high abundance class included the three most abundant species detected in each park, which had mean detections per survey >1.0 (INDU's high abundance class was ~0.5 detections per survey). The moderate and low abundance classes for each park consisted of species with mean abundance per survey ~ 0.25-0.75 and ~ 0.1-0.25, respectively. Species with mean abundance < 0.10 were not considered.

Results

All monitoring programs have been in place for over five years, with four parks (APIS, INDU, ISRO, and VOYA) having >8 years of data on a consistent set of points. All six parks have sufficient power to detect a 10% annual change in abundance after 10 years, or a 5% change after 15 years for at least some species (Table 5). Smaller population trends (2%) will take longer. Figure 1 shows the relationship between trend magnitude and required study duration for various amounts of temporal variation (CV). Although population declines are a bit more difficult to detect than increases (Gibbs et al. 1998), the differences in required duration for increases and decreases were generally very small (~ 1-3 years) for the species we evaluated. We report the required study durations for declines only; these estimates will be slightly conservative if also used for increases. Averaging across the five species with the minimum and five species with the maximum required durations, the mean minimum number of years to detect a 10%, 5%, or 2% trend was 7.5, 11, and 18 years, respectively; the mean maximum number of years was 20, 30, and >45 years.

On average, species in the high abundance class required 8.9 years of monitoring to detect a 10% trend, while the medium and low abundance classes required 12.7 and 14.2 years, respectively. Temporal variation in mean abundance (CV), as measured by the root mean square error from the regressions (in log scale) ranged between 0 and 1 for all species tested. Species in the high abundance class tended to have lower CV (mean = 0.18) while species in the moderate and low abundance classes had higher CVs (means = 0.31 and 0.39, respectively). Isle Royale National Park had the shortest required time to detect trends across species, although the difference among parks was not substantial.

Table 5. Number of years required to detect a 10, 5, or 2% change in mean abundance per survey for 10 species on Apostle Islands National Lakeshore, Grand Portage National Monument, Indiana Dunes National Lakeshore, Isle Royale National Park, St. Croix National Scenic Riverway, and Voyageurs National Park with power = 0.80 and alpha = 0.05. CV = root mean square error from a simple linear regression of ln(mean abundance) vs. year. H = high abundance, M = moderate abundance, L = low abundance.

Apostle Islands National Lakeshore

			Trend		
Species	Abundance	CV	10%	5%	2%
Red-eyed Vireo	H	0.112	7	10	16
Ovenbird	H	0.156	8	12	20
Black-throated Green Warbler	H	0.177	10	13	22
Blackburnian Warbler	L	0.208	10	14	24
Yellow-rumped Warbler (Myrtle)	M	0.233	11	15	26
Song Sparrow	M	0.256	11	16	28
Red-breasted Nuthatch	L	0.315	13	19	32
Nashville Warbler	M	0.355	14	20	35
Winter Wren	M	0.412	16	23	39
Magnolia Warbler	L	0.565	19	28	47

Grand Portage National Monument

			Trend		
Species	Abundance	CV	10%	5%	2%
Ovenbird	H	0.136	8	11	18
Northern Parula	M	0.196	9	14	23
Magnolia Warbler	M	0.206	10	14	24
White-throated Sparrow	H	0.206	10	14	24
Song Sparrow	L	0.236	11	15	27
Red-eyed Vireo	H	0.278	12	17	30
American Robin	M	0.362	14	21	35
Mourning Warbler	M	0.436	16	23	40
Black-and-white Warbler	L	0.474	17	25	42
Rose-breasted Grosbeak	L	0.937	24	36	>50

Indiana Dunes National Lakeshore

			Trend		
Species	Abundance	CV	10%	5%	2%
Yellow Warbler	H	0.216	10	15	25
Northern Cardinal	H	0.235	11	16	27
House Wren	M	0.358	14	21	35
Indigo Bunting	M	0.362	14	21	35
Song Sparrow	M	0.392	15	22	37
American Goldfinch	M	0.414	16	23	39
American Robin	H	0.443	16	24	40
Willow Flycatcher	L	0.542	18	27	46
Blue-gray Gnatcatcher	L	0.658	21	30	>48
Black-capped Chickadee	L	0.733	22	32	>48

Table 5 (cont.)

Isle Royale National Park

Species	Abundance	CV	Trend 10%	5%	2%
White-throated Sparrow	H	0.034	4	5	8
Least Flycatcher	M	0.047	5	6	10
Golden-crowned Kinglet	L	0.063	5	7	11
Ovenbird	H	0.087	6	8	14
Canada Warbler	L	0.174	9	13	22
Swainson's Thrush	M	0.177	9	13	22
Nashville Warbler	H	0.237	11	16	27
Black-and-white Warbler	M	0.404	15	22	38
Black-throated Blue Warbler	L	0.444	16	24	41
Veery	M	0.807	23	34	45

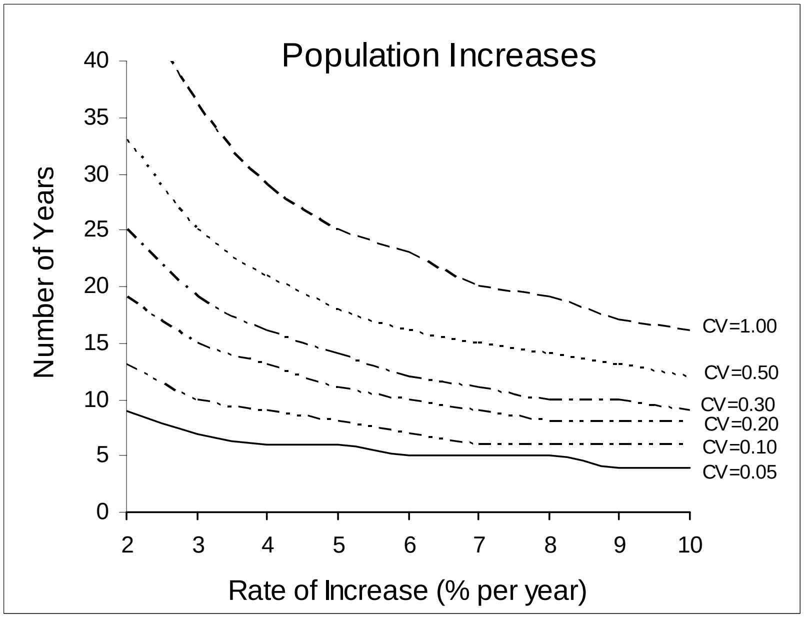
St. Croix National Scenic Riverway

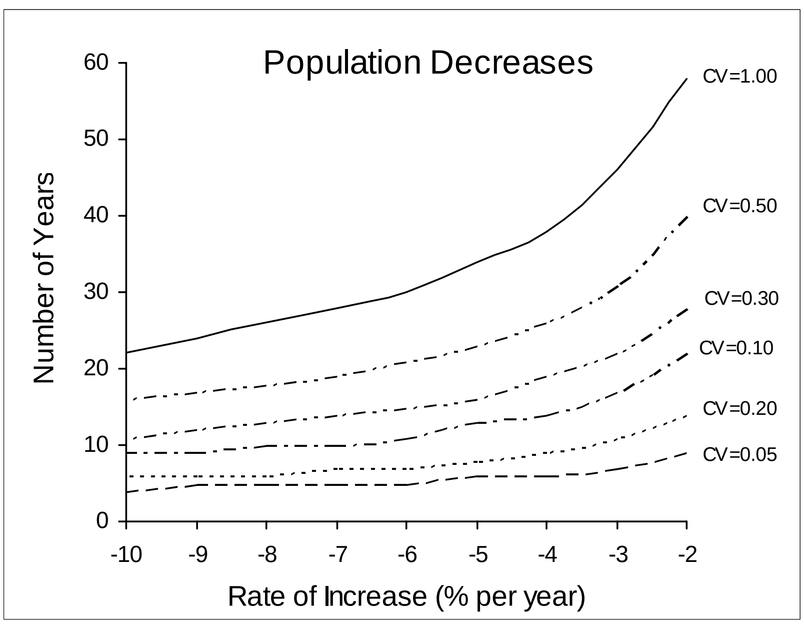
Species	Abundance	CV	Trend 10%	5%	2%
Least Flycatcher	L	0.046	5	6	10
Red-eyed Vireo	H	0.101	6	9	15
Song Sparrow	H	0.119	7	10	17
Great-crested Flycatcher	M	0.237	11	16	27
Warbling Vireo	L	0.255	11	16	28
Veery	M	0.262	11	17	29
Common Yellowthroat	H	0.276	12	17	30
Ovenbird	M	0.307	13	19	32
Baltimore Oriole	M	0.328	13	19	33
Scarlet Tanager	L	0.467	17	25	42

Voyageurs National Park

Species	Abundance	CV	Trend 10%	5%	2%
Ovenbird	H	0.075	6	8	13
White-throated Sparrow	H	0.138	8	11	19
Chestnut-sided Warbler	M	0.143	8	11	19
Red-eyed Vireo	H	0.171	9	13	21
Blackburnian Warbler	M	0.181	9	13	22
Northern Parula	L	0.244	10	16	27
Great-crested Flycatcher	L	0.254	11	16	28
Hermit Thrush	M	0.299	12	18	31
Veery	M	0.377	15	21	36
Brown Creeper	L	0.433	16	23	40

Figure 1. Minimum number of years of bird monitoring required to detect rates of annual population change for species with different coefficients of variation (CV).





Discussion

The existing monitoring programs have sufficient statistical power to detect trends for some species using data already collected. For many species, however, power to detect trends will only be adequate if monitoring is continued for several more years. The required duration of a monitoring program to detect a given species' trend is influenced by temporal variance, which is in turn generally related to abundance. Trends are generally more easily detected for common species because they tend to have lower temporal variation in abundance. However, just 10 years are required for Least Flycatcher in ISRO to detect a 2% annual change due to its low CV, despite it having low abundance within the park. The CVs for species in this analysis are comparable to published values; Gibbs et al. (1998) found that for 73 studies using small birds, the coefficient of variation ranged from 0.11 to 2.48 (mean = 0.57).

Temporal variation in abundance is influenced both by variation inherent in populations (e.g., annual fluctuation) and by sampling variance. Monitoring programs should be designed to minimize sources of variance related to sampling, by having a sufficient number of points and by controlling for wind, rain, and observer ability. This can reduce sampling variance, leaving the remaining population variance to be explained by the true population change. Although we did not directly evaluate the number of survey points necessary to detect significant population trends, Thompson et al. (2002) found that 100-300 point counts were adequate for monitoring on the scale of a national forest (at least twice the size of most of the parks considered here) over a 10 year period. Four of the six parks we considered had sample sizes of ~100 or greater. Grand Portage National Monument has a sample size of only 38 points, but this sample effectively covers the entire park and does not require substantially longer monitoring durations. The shorter required durations for Isle Royale National Park are probably because this park has the greatest number of survey points that have been surveyed consistently for the longest duration (130 points for 8 years); these factors combined to reduce CVs for species in ISRO. An additional possibility is that the survey points are located in habitats more homogeneous than in other parks, leading to lower spatial variation in counts. Because bird species abundance is closely tied to habitat, monitoring programs with wide variability in habitat types will require a greater number of points to reduce the spatial variance in counts.

Recommendations

Individual park recommendations

Apostle Islands National Lakeshore

The three monitoring objectives at APIS currently appear to be met. Annual data analyses could focus more on individual species trends (including island or habitat specific trends, if possible) and less on trends in total number of birds, total number of species, and diversity indices. Comparisons of trends with other regional monitoring programs would be beneficial. Methods that describe their allocation of samples proportionately to habitats at APIS were included in Van Stappen and Dallman (1996), but should also be included in annual reports, whenever possible.

The second objective pertaining to the description of important breeding bird habitats could be clarified. It is not clear whether importance is measured by high numbers of individuals or species, the occurrence of species of conservation concern, or some other measure. If the objective is not to single out a few habitats, then it might be rephrased as "to describe habitat associations of breeding birds within the lakeshore," or something similar.

The point count protocol is sufficiently detailed and does a good job of describing project background and objectives, methodology, weather criteria, habitat descriptions, equipment needed, and survey site descriptions. The protocol also includes revision dates.

Grand Portage National Monument

The main objective of the GRPO bird survey is to assess species distributions across different habitats. This objective can probably be met with the current sampling design, but the data still need to be analyzed in this context (S. Gucciardo, pers. comm.). Because of the relatively small size of the park, delineation of habitat types across the park and at the 38 survey points should be straightforward. Habitat at nearly 90% of the points has been categorized as birch-aspen-spruce-fir forests, but park personnel should try to determine if other distinct habitat types (e.g., aspen-dominated, spruce-dominated) exist within this general cover type.

Data from GRPO were provided in the form of a crosstab spreadsheet with species as rows and survey points as columns, with each year's data occupying a different worksheet. This made the data difficult to export and analyze. A database program should be used for data entry, where data can be stored in tables (similar to spreadsheets). Tables within the database should have separate columns for year, survey point, species, and number detected (preferably with each individual bird entered separately). The crosstab table can then easily be generated for summary reports, etc.

Time and weather data should be recorded at each point. Field data sheets include a pre-printed list of species, with an area for tallying individuals (e.g., one (/), two (//), etc.). GRPO should consider recording individual birds on a blank circle for their data sheets rather than a list of species, to avoid transcription and tallying mistakes. Each individual bird should be recorded separately when detected by the counter to avoid confusion during data entry.

Indiana Dunes National Lakeshore

The objective of the INDU Breeding Bird Survey is to track population trends of breeding birds. The park may want to consider expanding the number of survey sites to ensure adequate coverage of the park and fulfill this objective. The BBS route is certainly contributing to the national BBS effort, but it will be difficult to say much about the Lakeshore's bird population trends based on one route.

A table with totals from each year is available at the INDU website, but it would also be beneficial to have a report available that outlines how the route was established and what areas and habitats on the Lakeshore are covered, as well as a periodic summary of results. An evaluation of how representative the survey route is of the entire park would also be beneficial.

Isle Royale National Park

The three main objectives of the ISRO breeding bird survey are probably being met, assuming that survey points are representative of the island's forest types, and thus its bird communities. It is unclear whether this assumption can be made, and an attempt should be made to quantify the forest types at survey points in relation to the entire island. This would entail the use of a Geographic Information System. If resources are available, additional survey points should be added in under-represented forest types.

Data from ISRO were provided as a combination of spreadsheets and databases separated by year. If it has not already been done, all data should be combined in a single database, with a single table for all years' bird data. This will greatly facilitate data summary and analyses.

A point count protocol was not provided, so some details of the point count methodology could not be evaluated (although many details can be found in the park's annual reports). The park uses an unlimited radius, but ISRO should consider expanding it to include 100 m, and >100 m radii. Annual reports indicate that the 5-minute point counts are separated into 1-minute intervals, but comparisons with other surveys would be facilitated by breaking counts in 3, 5, and 10-minute intervals rather than 1-minute intervals.

Annual reports from ISRO indicate that their surveyors are encouraged to not use 4-letter species abbreviations unless they are familiar with all of them. This is an important consideration for all parks, especially if surveyors are conducting few surveys on a regular basis (standard 4-letter codes for many species are very similar, and not always intuitive).

St. Croix National Scenic Riverway

Because only one report was available, based on results from two transects surveyed in 1982, 1983, and 1998 (Maercklein 1999), it is unclear whether the objective of monitoring changes in relative abundance of bird populations is being met. If surveys continue on an every other year basis, the data are analyzed, and results are reported, then this objective is probably achievable. This assumes that survey points are representative of the park's habitats. Forest types at survey points should be quantified in relation to habitats across the park. This would entail the use of a Geographic Information System. If resources are available, additional survey points should be added in under-represented forest types. Survey points should be documented using a Global Positioning System (GPS), if it has not already been done. Three transects have been added since 2000, and a report or summary should be written describing these transects, how they were selected, and bird trend results to date.

Although breeding bird surveys at SACN have been conducted by the same personnel through the years, the protocol needs to be documented. The effect of drifting watercraft during surveys is potentially significant, because a different sampling unit is being surveyed each year, depending on the amount of drift. Anchoring during counts or surveying from shore should be considered. To accommodate comparisons with other surveys from the region, SACN should consider going to a 5-min sampling period (Ralph et al. 1995), with a 3-min interval to accommodate comparisons with the U.S. Geological Survey Breeding Bird Survey, if needed. During SACN bird surveys, a single observer records only the birds detected by that observer, but other observers are allowed to point out birds or their calls (R. Maercklein, pers. comm.). It is critical that only one person detect and record birds during point counts, without input (verbal or non-verbal) from additional observers.

Voyageurs National Park

The most recent statement of objectives for the VOYA breeding bird survey was from Grim et al. (1995). The objectives of 1) developing protocols for surveying forest birds, 2) estimating population trends, and 3) discovering invasions of exotic species, seem attainable given the study design and site selection methodology. However, beyond the 1995 report describing protocols, point counts, and data management, no reports of population trend analyses or habitat associations are available. The objective of defining habitat associations of avian trends is probably not attainable due to the difficultly of calculating a trend with small numbers of points in each habitat type. However, habitat associations of individual species (regardless of their population trends) could be described. This assumes that survey points along the remaining eight transects were proportionately stratified by habitats in the same manner that the initial 1995 transect was. The objective of documenting recovery periods following significant declines should fall under the objective of estimating population trends.

The VOYA protocol is dated from 1995 and should be updated as needed. It contains step-by-step details from data collection in the field, through data entry and database management. This is very helpful to long-term continuity, and a similar protocol that is updated periodically should be a goal for each park unit.

The table on the field data sheet for tabulating individuals could be eliminated and the circle enlarged. Tabulating birds in the field after each count takes extra time and may increase the error rate. It may be more efficient to enter individuals in the count circle straight from the data sheet to the computer.

<u>Network-wide recommendations</u>

- Consistency in methodology and protocol across all parks will increase opportunities for comparisons with national forests, the Breeding Bird Survey, and other regional and national monitoring efforts. We offer a recommended protocol, standard data sheet, and data base to assist in achieving this consistency (see supplements).

- Because breeding bird surveys are conducted on an annual basis in most parks, data should be analyzed and results reported on an annual basis as well. A short 1-2 page annual summary would be beneficial for re-evaluation of study objectives, methodology issues, and, of course, changes in bird populations (if this is an objective for the park). Annual reports could be used as public relations tools if justification is needed for spending time on analyses and report writing.

- The objectives of each park's breeding bird survey should be clearly stated and revised as needed. If an initial objective seems too ambitious, it should be dropped or modified. For example, the stated objectives for the ISRO breeding bird survey in 1995 included associating any observable population trends with changes in the vegetation of the island. This objective was dropped in 1996 due the extra resources needed to measure vegetation attributes at all survey points. All objectives have been clearly stated in each ISRO annual report.

- A current written protocol for conducting point counts, entering data, training requirements, etc. should be completed. Protocols should be revised on a regular basis, and previous versions should be archived (these can be used to assess the methodology used in previous years). A description of all codes used to record data should be included with the data, whether entered in spreadsheet or database form. Code descriptions should also be printed on field data sheets whenever feasible.

- Describe in detail methods used for site selection. Knowledge of how sites are selected is extremely important for making appropriate conclusions from the data. For example, if it is a goal to infer population trends for an entire park, then sites must be selected so the surveyed points are representative of the entire park, as with simple random or stratified random sampling. Data collected from randomly selected sites generally supports inferences that can be extended from the survey points to a wider area of interest (i.e., a park), while data collected from purposely selected sites may substantially misrepresent conditions over the intended area.

- If additional sites for surveys are to be included, they should be selected so that the final group of sites is representative of the area for which the conclusions will be made. This may be achieved in a simple manner by randomly selecting new sites proportionately in habitats that are presently underrepresented. Alternative, more complex sampling mechanisms using stratification could also be used, but may require more complicated statistical analyses (e.g., weights for different strata). Increasing the number of points should reduce the variability of the data, which should reduce the amount of time required to detect population trends.

- All data should be entered directly into a database program (e.g., Microsoft Access) and spreadsheets should be avoided, if possible. Data can be entered in a database either through a customized interface (not required), or data can be entered directly into tables within the database (similar to a spreadsheet).

- Observer training requirements and methods to train observers should be described in detail and included in all reports, or at least referenced. Suggested requirements include bird song identification tests (e.g., tapes or CDs), visual identification tests (e.g., slide shows), a hearing test conducted by an audiologist, distance estimation, and data entry procedures. Recordings of bird songs and calls should be provided to surveyors before the field season. Additional materials should be provided to surveyors that address identification of target species, especially those difficult to identify (e.g., Eckert 1996, 1997, 1998, 1999). A list of expected species should be provided along with their typical habitat associations.

- If multiple observers are used during a field season, counts should be stratified equally by habitat type so that no single person is sampling all points of a specific habitat type.

- All parks are encouraged to have surveyors record individual birds detected into distance categories (e.g., 50m, 100m, 100+m radii), regardless of whether data are currently analyzed with distance sampling techniques to assess detection probabilities (a potentially important consideration when analyzing trends and habitat use). This will require training in distance estimation, but should be relatively easy to implement since observers can record birds in categories rather than trying to record exact distances to each bird.

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Literature Cited

Beeman, J.L., and J.G. Oelfke. 1996. 1996 breeding bird survey at Isle Royale National Park, Michigan. Isle Royale National Park Resource Management Report 96-3. National Park Service files, Houghton, MI.

Eckert, K.R. 1996. Birding by hindsight: a second look at songs (part 1). The Loon 68:62-66.

Eckert, K.R. 1997. Birding by hindsight: a second look at songs (part 2). The Loon 69:32-37.

Eckert, K.R. 1998. Birding by hindsight: a second look at songs (part 3, warblers). The Loon 70:52-57.

Eckert, K.R. 1999. Birding by hindsight: a second look at songs (part 4). The Loon 71:42-46.

Egan, A. 2004. 2004 Breeding bird survey. Isle Royale National Park, Michigan. Resource Management Report 04-1.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68: 1364-1372

Gerrodette, T. 1993. Trends: software for a power analysis of linear regression. Wildlife Society Bulletin 21: 515-516.

Gibbs, J.P., S. Droege, and P. Eagle. 1998. Monitoring populations of plants and animals. BioSscience 48(11):935-940.

Grim, L.H., S.R. Lammie, and J.P. Schaberl. 1995. A forest breeding bird survey protocol for conducting point counts in Voyageurs National Park, Minnesota. US Department of Interior, National Park Service Report VNP-PRTCL-1-BBS.

Hanowski, J.M, J. Lind, N. Danz, G.J. Niemi, and T. Jones. Regional breeding bird monitoring in western Great Lakes national forests. Proceedings of the Partners In Flight Conference 2002, Asilomar, CA. In press.

Hanowski, J.M., and G.J. Niemi. 1995. Experimental design considerations for establishing an off-road, habitat specific bird monitoring program using point counts. Pages 145-150 in Monitoring bird populations by point counts. General Technical Report PSW-GTR-149. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

Howe, R.W., G.J. Niemi, G.J. Lewis, and D.A. Welsh. 1997. A standard method for monitoring songbird populations in the Great Lakes region. Passenger Pigeon 59:182-194.

Link, W. A., and J. R. Sauer. 1997. New approaches to the analysis of population trends in land birds: comment. Ecology 78:2632-2634.

Maercklein, R. 1999. Bird monitoring in the St. Croix National Scenic Riverway. Passenger Pigeon 61:311-317.

Nur, N., S.L. Jones, and G. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service, BTP-R6001-1999.

Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA. 41 pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966 - 2003. Version 2004.1. USGS Patuxent Wildlife Research Center, Laurel, MD. Available at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html (accessed December 2004).

Thompson, F.R., D.E. Burhans, and B. Root. 2002. Effects of point count protocol on bird abundance and variability estimates and power to detect population trends. Journal of Field Ornithology 73(2):141-150.

Urquhart, N. S., and T. M. Kincaid. 1999. Designs for detecting trend from repeated surveys of ecological resources. Journal of Agricultural, Biological, and Environmental Statistics 4:404-414.

Van Stappen, J. F. and M. E. Dallman. 1996. Apostle Islands National Lakeshore 1995 Breeding Bird Survey Report. Passenger Pigeon 58:35-46.

SUPPLEMENTAL DOCUMENT 1

NRRI Point Count Protocol

Background and objectives

ARRANGEMENT OF POINTS

Approximately 1200 survey points are spread throughout Minnesota and northwestern Wisconsin. The points are grouped into three study areas: Chequamegon NF, Chippewa NF, and Superior NF.

Birds are typically surveyed at 12 point counts within a Forest Service compartment by one observer in one morning. Each compartment is divided into stands, typically with 3 points in each stand. A stand is usually a homogeneous patch of forest. The minimum distance between points is 220m but the distance can be further, especially between stands.

Points and the routes between points have been marked with pink flagging and orange paint, with points usually, but not always, having a tree with a numbered metal tag. Yellow paint has also been used in the past in the Chequamegon NF (this year we will be using pink). It is important go to **each** of the points you will be surveying on the day before the count, and mark the routes with flagging. In the early hours, orange paint can be hard to see, so you may want to be more liberal with pink flagging on the points that will be done first. One important caveat: different colored flagging and paint is often used by foresters, hunters, etc. and can be confused with our marking scheme, but we only use orange paint and pink flagging (except pink paint in the Cheq. NF).

BIRD SURVEY PROTOCOL

Surveys should be conducted from approximately 0.5 hour before sunrise to 4 hours after sunrise (~0445 to 0930 local time). Surveys should only be conducted during "good weather" – i.e. wind <12 mph and little or no precipitation. Do not survey when weather conditions affect the birds' singing. If the rain is falling harder than a light mist, you should probably discontinue the survey. However, there are times when bird activity picks up during a light rain. The decision to discontinue a survey due to wind is complicated by the fact that the wind often gusts, resulting in unacceptable conditions sometime and acceptable conditions during other times. The decision as to whether or not you should conduct or continue to conduct a survey is at times a largely subjective one. The question underlying this decision is this: Are there noticeably fewer birds singing as a result of the weather? If so, you should discontinue the survey. In addition to the weather codes, be sure to provide details in the "notes" section of the data sheet if a survey is done during questionable weather.

It is important to move between points in a timely manner. Although there is usually enough time allotted to finish the surveys before the four hours after sunrise cutoff (~0930), the later surveys may result in reduced numbers of birds. By finishing the surveys as early as possible (without cutting short the survey period, of course), time-of-day effects are reduced. Do not spend time trying to find an unknown species if there are remaining points to census.

The following information should be collected at each point:

(1) Weather and noise information: Remember to record temperature, wind, sky, and noise codes, as this may be used later to determine if weather or noise were factors affecting the survey. Please provide details in the "notes" section of the data sheet if a survey was done during questionable weather.

(2) For a **10-minute period**, record all individuals observed or heard singing or calling for an unlimited radius, with those individuals within a 100m radius noted. See data form for specific codes to use. Remember to specify the time period (1, 2, or 3) when you first heard or saw the bird. Record a 4-letter code for each individual detected (e.g. WTSP, WTSP <u>not</u> WTSP-2).

Each individual must be recorded, identified or not. Individuals which cannot be <u>positively</u> identified should be recorded as an unidentified species (e.g. unidentified passerine, unidentified woodpecker, etc.). The inability to identify every individual does not count against you and is, in fact, expected. What is not acceptable, however, is not recording individuals you are unable to identify – this can greatly affect survey results.

Make every attempt to estimate distances accurately. Be sure you can locate a bird's location from its song or call with good accuracy. Be aware that your ability to accurately locate birds may vary with species. When recording a bird's location on the data sheet, put it to either side of the 100m circle so it is obvious whether it is inside or outside of 100m.

Remain at the point and record data for the entire 10 minutes. Resist the temptation to cut the survey short if the point is quiet or the insects are especially bad. Likewise, do not include any birds before or after the 10 minutes. If you feel it is important to note their presence (i.e. a rare species), record the data in the "notes" section of the data sheet, where it will not be inadvertently included in the survey (remember, others will be proofing this data).

Other items to include in the "notes" section are:

- Details on weather conditions (for determining the reliability of the count)
- Details on unusual species seen or heard
- Description of logging activities, beaver flooding, etc.
- Tips on finding survey location (be sure to note these on the maps as well)
- Details on any nests found or fledglings seen

If a point is not surveyed, note the reason on the sheet and staple with the other points done that day. Also record this information on the "List of points not surveyed." Any points that have been recently cut, or which have obvious incorrect FS Type designations, should be noted on the "List of points with FS type changes." Filling out these two lists should be a <u>daily</u> routine.

When entering data, be sure to write your initials and the date entered on the top of your data sheets.

Equipment Needed

COMPARTMENT MAPS

Due to the large number of points and the fact that different people conduct point counts each year, it is crucial that we have and maintain good maps and directions for all points. Each forest compartment has a sheet protector containing a hand drawn map, often with a topo map and/or older hand drawn maps, which are arranged in 3-ring binders by forest district. The maps should be taken into the field, but care should be taken not to get them wet or lose them. Any additions or changes to the maps (new directions, recent cuts, access issues) should be made as soon as possible after visiting the compartment. If a map becomes extremely cluttered or hard to read, it should be redrawn (preferably traced off the old one or off a Forest Service map). The old map should be kept in the sheet protector and not thrown away.

Many of the compartment maps have stand boundaries drawn on them, a code (which usually look like a fraction) that gives the stand number (numerator) and the forest type (denominator). The forest type is usually a 3-letter code, with the first 2 digits being the forest type (usually a tree species) and the third digit is the size and stocking density. For example, for FS Type 913, 91 is the code for aspen and 3 is the code for high density seedling-sapling. Stocking density can range from 0-9, but is usually 0 (open), 3 (seedling-sapling <~5" dbh), 6 (pole-timber: ~5-9" dbh), or 9 (sawtimber: ~9+" dbh). Each clipboard has a detailed descriptions of all codes. If you feel that the FS type designation is inaccurate (due to logging, succession, etc.), be sure to indicate what you think it should be changed to, on the "List of points with FS type changes." Don't worry much about changing the stocking densities, unless they are obviously inaccurate (i.e. an open clearcut designated as a 6 or 9). The 3-digit code for FS type is also on all of the point count data sheets.

SAFETY

Each of us will be working alone in remote areas on a daily basis, so there are some important safety issues to keep in mind. With a large field crew and widely scattered study sites, it is important that someone will notice if you are late in returning to "base." Situations and logistics will change daily, so it is difficult to determine an exact time that each person should be back from the field. Communication between everyone on the crew <u>before</u> heading into the field will be extremely important not only for safety's sake, but for getting the field work done and travelling between destinations within a reasonable time. This does not mean that you should take chances for the sake of finishing early, but keep in mind that there will be concern if one of us is much later in returning than the rest of us.

In 1999 there were two large "blowdowns" that affected some of our compartments in the Superior and Chequamegon National Forests. Be careful maneuvering around fallen trees and be aware of any damaged trees that are standing or leaning that could potentially fall. Also, if you smell smoke at any time, get out of the woods ASAP and don't go back until you know it is safe. The fire danger may be high with all the extra fuel present in these areas.

As with any field project, keep in mind the importance of having ample water and food in the field, map and compass, warm clothes, insect repellant and headnets, checking for ticks, etc.

Use your radios!